

How the Public

Views

Research points to better ways to address widespread misconceptions about the problem and how to solve it.

Climate Change

By Willett Kempton



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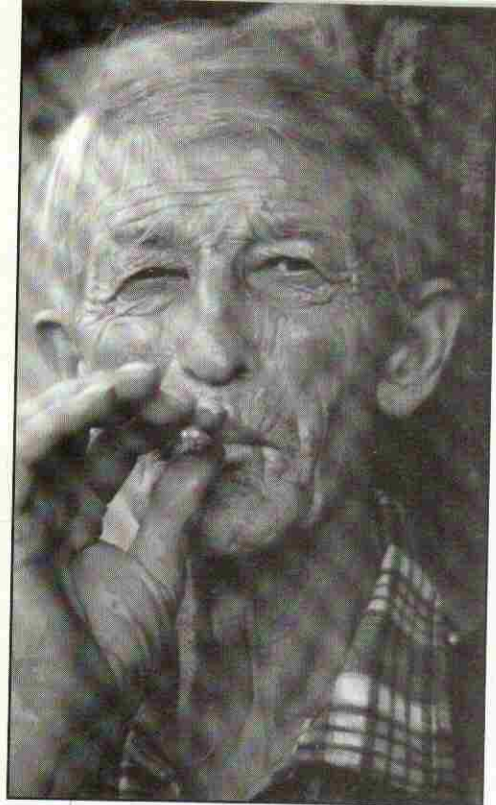
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How do policymakers decide what to do about a problem such as global climate change? Should they, for instance, sign an international treaty with binding commitments to reduce greenhouse gas emissions? Scientists and policy analysts would like to believe that such decisions are based on the best science available and that the costs and benefits are balanced impartially. But elected leaders also have to consider how voters feel about these issues.

Social and political scientists usually attempt to gauge voter sentiment by conducting a survey. By asking questions such as "Are you concerned about global climate change?" they obtain information in the form of percentage distributions of public opinion. This enables them to make statements such as "[s]eventy-one percent of registered [U.S.] voters . . . said they believe global climate change is either a 'very serious' or a 'somewhat serious' threat."¹

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Although this approach seems straightforward, the results are often highly ambiguous. The problem with asking people about global climate change is that most of those polled have not thought about the issue at any length and thus cannot give meaningful responses. And even if analysts accept the result that voters consider global climate change "serious," that information does not indicate which policies they will support. Other surveys show, for instance, that while 83 percent of U.S. voters support higher fuel efficiency standards, only 23 percent support taxes on energy.² In other words, the policy that could have the largest effect enjoys the least public support. Public misconceptions about possible solutions are another significant problem. For example, 66 percent of U.S. voters believe that "reducing pollution is a more effective way to prevent global climate change than energy conservation,"³ whereas most analysts would say just the reverse.



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Cultural Models of Climate Change

Air Pollution

Many of the people interviewed view the greenhouse gases responsible for climate change as a form of air pollution. The following statement, made by a resort proprietor in Maine, illustrates this view perfectly:

[N]ow they're polluting the air by burning the garbage. And they say that they have equipment that prevents the air from being polluted. . . . On the other hand, the people say that their cars are losing their paint in the immediate area of the incinerator and that the paint is peeling off the houses and I suspect that in due course, several years down the road, they will discover that the incidence of cancer around the incinerator, which fortunately is located some distance from us here, is on the upswing.

If people lack detailed knowledge of global climate change, how do they form their opinions on this issue?

Intensive interviews with and surveys of a wide variety of U.S. voters from 1989 to 1992 suggest two answers.⁴ First, they apply concepts drawn from their understanding of other environmental problems, particularly pollution and ozone depletion. Second, they appeal to more general concepts about the environment, observations about the weather, and broad environmental values. Both types of concepts entail what anthropologists call *cultural models*—that is, conceptual models of the fundamental ways in which the world works that are shared by most of the people in the culture.⁵ Understanding these cultural models is important for two reasons: It makes the results of climate change surveys more intelligible, and it will be essential if scientists and public officials are to communicate effectively with each other and the public on this complex issue.

This article examines cultural models that U.S. voters use in an attempt to understand global climate change. It will suggest how popular misconceptions arise and how better communication could improve the public's understanding of this issue.

Statements like this one imply that this particular cultural model has four elements: Pollution consists of artificial chemicals rather than natural substances; these chemicals are toxic to humans and other forms of life, although the adverse effects may not be observed until much later; automobile and industrial emissions are the principal sources of these chemicals; and pollution can be prevented by installing more filtering equipment.

As it happens, all of these beliefs based on the pollution model are either incorrect or irrelevant to the problem of global climate change—and the mismatch between the model and reality has serious consequences for our efforts to solve the problem. One unfortunate consequence of the air pollution model is that it leads to incorrect inferences about health effects. For example, a hospital administrator said that she was concerned about the greenhouse effect not because of temperature changes but because “we are ingesting and breathing in all these different chemicals that are being put into the atmosphere.” This conclusion is invalid because the principal substance responsible for climate change—carbon dioxide—is not

toxic. (Some lesser greenhouse gases such as methane are toxic, but these gases are far too dilute in the atmosphere to have any health effects.)

The general pollution model is also misleading because it implies that end-of-pipe pollution controls are the solution to climate change. For example, a pharmaceutical technician suggested using “an incredibly fine filter” to trap carbon dioxide emissions from industry. Although filters work for particulate air pollution, greenhouse gases are not particles. In fact, no cost-effective control technology has been demonstrated for carbon dioxide, and most current pollution-control technologies *increase* carbon dioxide emissions. Most analysts say that emissions reductions can only be achieved through improved energy efficiency and switching to nonfossil fuels—solutions that are not consistent with the air pollution model.

A third problem with the pollution model is that it obscures the roles of invisible and seemingly nonpolluting human activities, such as farming, clearing land, and using energy inefficiently.

Misconceptions like these are very common among U.S. voters. In the interviews in question, two-thirds of those who provided enough detail for analysts to discern a cultural model inappropriately applied pollution concepts to global climate change. This, of course, jibes with the survey result mentioned earlier that 66 percent of U.S. voters incorrectly stated that “reducing pollution is a more effective way to prevent global climate change than energy conservation.”

Ozone Depletion

A second cultural model often applied to global climate change relates to ozone depletion. In one sense this is surprising, because depletion of the stratospheric ozone layer is largely unrelated to climate change. However, both of these problems involve the atmosphere and there has been extensive news coverage of ozone depletion for nearly two

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decades. As a result, the two issues have become linked in the public mind. Consider, for example, how one man responded when asked if he had heard about the greenhouse effect: "Is that what they're talking about the ozone layer? . . . [That] last year . . . create[d] the hot spell . . . through the gases and that in the cans, you know, pressurized cans?"

While this man had only a ninth-grade education, the same blending of ozone depletion with climate change exists in the mind of a college graduate who warned us that she was atypical because she has talked with scien-

tists about the greenhouse effect: "Most people say burning fossil fuels is changing the climate because we are making the ozone layer disappear, that's the layer that protects us from the sun's harmful rays. This will greatly affect the climate over the next 100 years."

Although climate scientists have identified some interdependencies among climate change, tropospheric (ground-level) ozone pollution, and stratospheric ozone depletion, these are definitely lesser effects—respondents are clearly off-base when they give "the ozone layer" or "pressurized

cans" as causes of global climate change. (Under U.S. law, spray cans no longer contain ozone-depleting chlorofluorocarbons (CFCs).)

Occasionally, even major national media confound ozone depletion and climate change. For example, a *U.S. News & World Report* article described "ozone-depleting carbon-dioxide emissions," and the *New York Times* has more than once referred to carbon dioxide as damaging the ozone layer.⁶ To be fair, these mistakes were made by writers who are not primarily science writers, people who, after all, are as liable as any other lay person to overextend familiar cultural models. (For more on the ways in which press accounts subtly affect public opinion by invoking inappropriate cultural models, see the box below.)

Photosynthesis and Respiration

Plant photosynthesis and respiration provides yet another cultural model

NEWS REPORTING—BETTER AND WORSE

In news reporting on global climate change, small differences in word choice and phrasing can affect the likelihood that the reader will apply a misleading cultural model. Consider, for example, the following characterization of "global warming" that appeared in a recent *Time* article: "a gradual rise in worldwide temperatures caused by man-made gases trapping too much heat from the sun."¹ To a physical scientist, this would probably seem to be a reasonable explanation to give lay people. From the standpoint of effective communication, however, it has two major drawbacks. First, by referring to "man-made gases," it suggests that pollution is the cause of global climate change. Although one could argue that carbon dioxide emissions (and even animal respiration) are forms of pollution, this framing of the problem leads to a host of misconceptions, as shown in the text. Second, it highlights the warmer temperatures that will result from such change rather than the more important changes to ecosys-

tems, rise in sea level, crop losses, and so forth.

A less misleading characterization appeared in the *New York Times* about the same time: "[A]t least some of the climate change being observed in the world is likely to have been caused by human activities like the burning of coal, oil, and wood, which produces carbon dioxide."² Here, the cause of climate change is given as "burning" certain fuels rather than simply "gases," the specific fuels are named, they are said to "produce" rather than "emit" carbon dioxide (the word *emit* being associated with pollution), and the end result is called "climate change" rather than "warming."

A newspaper article on the automobile industry offers another good example of a way to explain climate change: "Carbon dioxide is produced in large quantities when gasoline is burned. . . . Reducing carbon dioxide emissions means improving fuel economy or reducing the number of cars on the

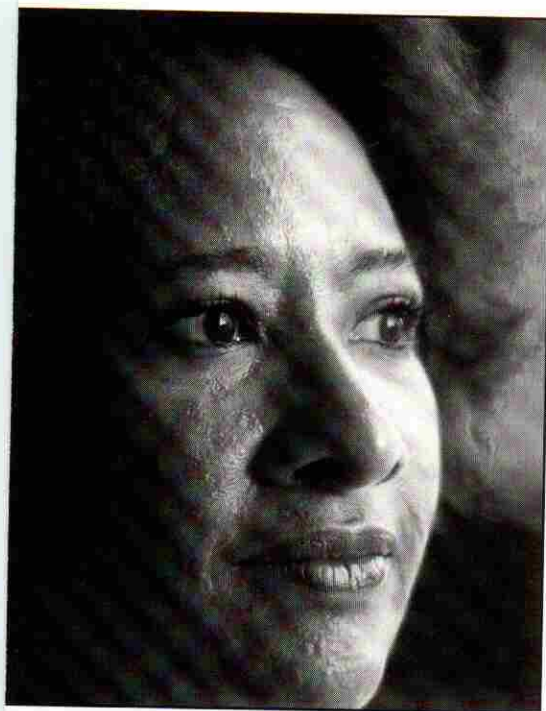
road."³ This statement not only largely avoids references to pollution (although the advantage of using "produced" is partially foregone by the later reference to "emissions"), it also lists specific ways to deal with the climate change problem. This makes it difficult for the reader to conclude that pollution controls are the solution.

Although most scientists and policy analysts would probably see little difference in these three statements, the last two are clearly preferable because they avoid misleading cultural models and provide information relevant to the solution. For this reason, statements like these should serve as models for effective communication on climate change.

1. M. D. Lemonick, "Heading for Apocalypse?," *Time*, 2 October 1995, 54.

2. W. K. Stevens, "In Rain and Temperature Data, New Signs of Global Warming," *New York Times*, 26 September 1995, C4.

3. K. Bradsher, "Automakers Seek to Halt Tough Rules on Clean Air," *New York Times*, 29 June 1997, A16.



UNICORN STOCK PHOTOS—JEFF GREENBERG

for global climate change. For example, several of those interviewed knew that trees extract carbon dioxide from the atmosphere and produce oxygen. From this and media accounts of the fact that deforestation is raising the level of carbon dioxide in the air, some inferred that humans would eventually exhaust all of the oxygen in the atmosphere and be unable to breathe. As one interviewee put it, "That's what scares me. . . . When they cut all the forests down, they say, pretty soon we're not going to have any oxygen to breathe. Why do they let them do that?" The survey conducted in conjunction with these interviews showed that 77 percent of the U.S. public shares this concern about breathing.

People who apply this cultural model to global climate change may become needlessly alarmed about the changes in store. Because carbon dioxide constitutes only 0.03 percent of the atmosphere by volume, doubling (or even octupling) its level would not appreciably lower the concentration of oxygen, which is 21 percent. Many urban office buildings, in fact, already have concentrations of carbon dioxide eight or more times as

high as that of the atmosphere.⁷ The fact is that increases in the level of carbon dioxide in the atmosphere in no way threaten the Earth's supply of oxygen or humans' ability to breathe. Unfortunately, however, the photosynthesis-respiration model of climate change not only leads to unwarranted fears but also shifts the emphasis from reducing fossil fuel consumption to preventing deforestation, which current evidence suggests is a less effective way to combat climate change.

Weather

Naturally enough, voters also apply cultural models about the weather to global climate change. Here too, they have important misconceptions, including the extent to which human activities affect climate, the degree to which the climate has already changed, and the precise consequences of global climate change.

The effect of human activities on climate. When asked what factors affect the weather, interviewees gave some predictable responses (such as the jet stream and sunspots), but more often

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they attributed changes in weather patterns to human perturbations, including "pollution," "burning forests," "spraying insecticides," and "auto pollution." In the interviews, three people mentioned space shots as a factor that affects the weather and one mentioned atomic bomb testing. For example, in response to a request for solutions to the problem of global climate change, one factory foreman said, "Well, I don't know what the hell they're doing up on the moon and shooting those things up there. I think they're disturbing the atmosphere. So much rain

we've had, so much rain." And in the survey, 43 percent of those polled agreed that "[t]here may be a link between the changes in the weather and all the rockets they have fired into outer space." The frequency with which anthropogenic causes were mentioned makes it clear that people consider human activities to be a major factor in weather changes.⁸

The interviews and survey results both suggest that people are predisposed to believe that human activities affect the weather, especially those activities that are regarded as unnatural or immoral (e.g., space shots, atomic bombs, and pollution). The practical conclusion is that those who are trying to raise public concern about global climate change need not worry that lay people will find the idea of human influences implausible. On the contrary, those trying to dampen public concern have to address the fact that the public is quite ready to accept such influences as important.

Climate changes that have already occurred. According to the interviews and survey results, a majority of U.S.

voters believes that the climate has already changed. Some reported that they had personally observed warming (typically in the form of milder winters) with such statements as "We used to have snowdrifts all the way up the telephone poles. . . . Now, you get a couple of inches and they close the schools." This view is by no means uncommon. Eighty-three percent of the survey respondents agreed that "you can already notice the effects of global climate change on the weather around here."

Another common observation made

by participants in the interviews is that weather patterns are becoming less predictable. For example, a retired machinist said that the seasons "don't seem to run the same. . . . Like now, in the spring, you get real hot weather like the summer; and then when the summer comes you got weather that's like the spring." Once again, the survey shows that this observation is widespread, with 79 percent of the public agreeing that "[t]he weather has been more variable and unpredictable recently around here."

It is difficult to interpret these observations. On the one hand, it would seem to be very hard for lay people to discern a global climatic trend from their own casual observations of local weather. On the other hand, both higher temperatures and more erratic weather—the two lay observations most commonly reported—agree with climatologists' conclusions. (For more on the science of climate change, see

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the review by William C. Clark and Jill Jäger on page 23 of this issue.) One point is clear, however: These data do not provide any basis for the concern expressed by some climatologists that lay people would not notice global climate change or else would not attribute it to human activities.⁹ On the contrary, this evidence suggests that most U.S. voters believe they have observed a change in the climate. Current publicity about global climate change has apparently given people a framework into which they can fit their own observations. Given many

people's predisposition to attribute changes in the weather to unnatural human activities, this may explain why the public at large has so readily accepted the seemingly implausible suggestion that human activities are warming the entire planet.

Consequences of climate change. As far as the specific effects of global climate change are concerned, U.S. voters tend to employ a rather simple cultural model, namely that changes in climate will simply mean "hotter weather." When interviewees were initially asked about the consequences of

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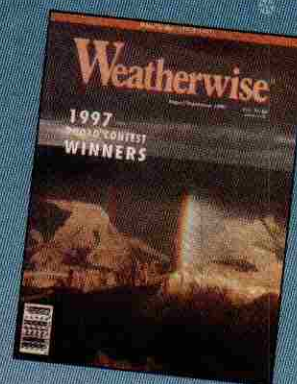
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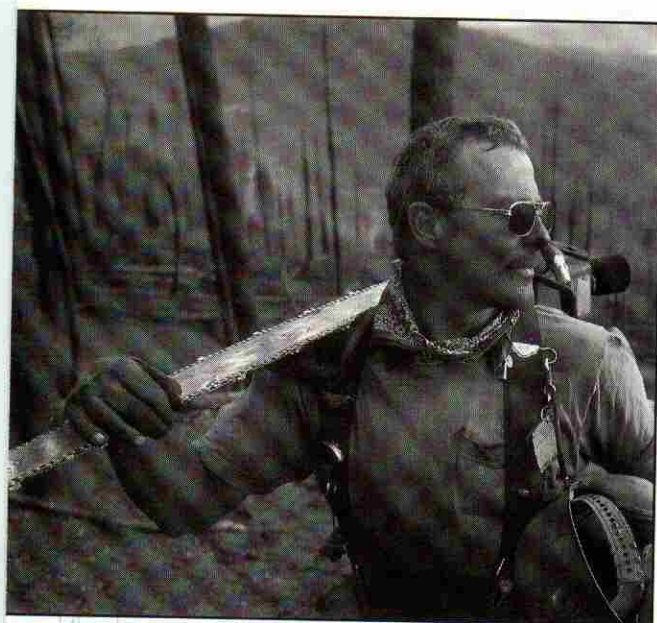
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problem in proper perspective, analysts and those communicating with the public should probably drop the term *global warming* and use *global climate change* instead.

Environmental Values

Cultural models like those just examined help to explain why people perceive environmental problems as they do. These models do not, however, reveal why they care about the environment or why they are more concerned about some issues than

others. To shed light on those questions, we have to study their values, that is, the moral guidelines they use in making decisions. On that score, the interviews indicate that because of their core values, U.S. voters strongly favor protecting the environment in general and preventing global climate change in particular.

The interviews also suggest that concern about the environment can stem from several different sets of values. Some of those interviewed, for instance, favored environmental protection for religious reasons, arguing that species should be protected "because God created them." Others did so for reasons related to human use, like the interviewee who said, "If we cut down all the rainforests . . .

we're going to lose out on a lot of chemicals and drugs." Still others took a more biocentric view, asserting that "[n]ature has intrinsic worth, apart from its human use." Such differences in values will influence which environmental issues people will be most concerned about and which policies they will prefer.¹⁰

Environmental Education Programs

As the preceding sections have shown, U.S. voters have strong environmental values but often apply inappropriate cultural models to the issue of climate change. Although this can lead to misconceptions about the problem as well as to support for ineffective solutions, it also offers advocates of effective action a real opportunity. By appealing to widely shared values and invoking those cultural models that facilitate understanding, they should be able to garner public support for the policies that will actually ameliorate climate change.

The importance of proper communication to science policy becomes clear when one compares public education on global climate change in the United States with that in the United Kingdom. In the United States, the federal government has not developed any substantial education program for the general public. Rather, it has left this task to the mass media and to advocacy groups with interests of their own to promote. With an issue as complex

the greenhouse effect, warmer weather was usually the first one they mentioned and, in some cases, it was the only consequence of which they were aware. This may stem from use of the term *global warming* as a synonym for climate change. This view can, however, lead to a certain indifference about prospective developments in climate. As one interviewee stated after being informed that climate change could raise the average temperature of the planet 3° to 9°F, "I certainly don't care as an individual whether it's 9 degrees warmer. Living in New Jersey, it can be 40 degrees different than it was yesterday."

When climatologists or biologists speak of "global warming," however, they are implicitly referring to a number of highly significant geophysical and ecosystem effects. These include changes in weather patterns, more violent tropical storms, a rise in sea level, possible shifts in ocean currents that could cause major regional climate changes, shifts in ecological zones, and alterations in the areas suitable for farming. Warmer temperatures per se, which lay people tend to associate primarily with the discomfort they feel on hot summer days, are probably the least important potential consequence of global climate change. To place the

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and uncertain as climate change, allowing competing interests to dominate the debate will not bring out the issues at all well. Because industries with strong economic interests have invested in advertising campaigns promoting the views of “skeptical scientists,” the information available to the public has probably been distorted.¹¹ Even without the deleterious influence of special-interest money, the “facts” that legislators receive from this highly charged public debate hamper their ability to make decisions.¹²

Last year, for example, I proposed to federal agencies some ways to develop a public education program for the United States, including conducting focus groups to see which explanations of global climate change were most effective at replacing inappropriate cultural models with better ones. They told me that this would not be possible because some members of Congress consider focus groups to be a way of “promoting a leftist agenda” among the public. In fact, these members of Congress were already bringing agency and department heads to task on the matter.¹³

More recently, however, the White House has stepped up its public communications efforts. Recognizing the need for citizen support for a new climate change treaty, President Bill Clinton has publicly declared:

In the United States, in order to do our part, we have to first convince the American people and the Congress that the climate change problem is real and imminent. . . . We will work with our people, and we will bring to the Kyoto conference [in

December 1997] a strong American commitment to realistic and binding limits that will significantly reduce our emissions of greenhouse gases.¹⁴

This statement explicitly acknowledges the Clinton administration’s intention to put public pressure on Congress to approve the treaty commitments it makes in Kyoto. But rather than conducting a true public communications campaign, the administration decided to confine itself to a conference of experts and a series of well-publicized regional panels prior to Kyoto.¹⁵ To be sure, a conference attended by the president and regional panels will make the climate change issue more visible and will generate some valuable media coverage. This approach has an important drawback, however. In preparing for the conference and other public events, the administration will probably focus on figuring out how to present a watered-down version of climate science—whereas what they really need to do is to test alternative versions of their presentation so that they will be able to invoke the right cultural models when discussing the issue.

The British Program

Unlike the Clinton administration, the British government conducted a major campaign to inform the public about global climate change. Though well conceived and to some extent successful, this effort too had important drawbacks, particularly with regard to overcoming preexisting cultural models.

Three factors in particular prompted the British communications effort: first, a survey revealing the British public’s lack of understanding of and misconceptions about global climate change (known as the Hedges Report); second, Britain’s commitment to stabilize its emissions of carbon dioxide by the year 2000; and third, the personal commitment of Prime Minister John Major. The campaign was substantial, with a budget of £6.2 million (about \$9 million) and full-page advertisements in major newspapers. Three primary themes were stressed: The first was that global climate change is both serious and frightening. One of the advertisements, for instance, included images of major storm damage, while another showed a tea kettle steaming on the stove as a metaphor for the Earth’s heating up. The second theme was that voters’ own energy use is the cause of global climate change. To drive this point home, the advertisements featured images of houses and heavy traffic. The third theme was that by participating in a government program offering subsidies for energy-saving home improvements (such as adding insulation), Britons could reduce their energy costs and help prevent global climate change.

At first glance, this seems like a logical program—raise public concern about climate change, identify energy use as the primary cause, and promote energy-conservation steps that consumers themselves can take. The problem is that the program was not designed to replace existing cultural models, which have a strong tendency to persist.¹⁶ Indeed, a survey conducted after the program was over revealed that it had had little effect on the public’s use of inappropriate cultural models. When asked about the consequences of the greenhouse effect, for example, 46 percent of those surveyed said, “It will be hotter.” The next most common response was “flooding” (24 percent), followed by the statements that climate change would “destroy [the] ozone layer” (21 percent) and

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that there would be "more cancer" (19 percent). Regarding the causes of the greenhouse effect, 35 percent said that it was cars and industry, 28 percent simply "emissions," and 27 percent spray bottles or chlorofluorocarbons; only 8 percent said that it was fossil fuels and another 8 percent carbon dioxide.¹⁷ Perhaps it is not fair to expect a media campaign to reach a large proportion of the public; but it is clear from the fact that these answers correspond closely to the cultural models mentioned above that, despite the media campaign, most Britons are still trying to understand climate change using the wrong models.

Goals for Communication Programs

As the British example indicates, anyone trying to communicate with the public about global environmental change has to address preexisting cultural models and concepts and not simply assume that he or she is writing on a blank slate. Recent studies of risk communication also support this conclusion. For example, a group at Carnegie-Mellon University in Pittsburgh found that communication with the public is more effective when it addresses preexisting models specifically than when it is based solely on general principles.¹⁸

As an example of using models-based communication in the area of climate change, consider the question of what society can do to prevent such change. Scientists and policymakers largely agree that effective action must begin with reducing our reliance on fossil fuels (either by using such fuels more efficiently, finding substitutes for them, or some combination of the two). Many members of the general public, however, believe that the solution is to ban aerosol cans, institute more controls on pollution, or stop deforestation. Some feel that the problem is simply too large to be solved or that it will require unrealistic changes in lifestyle.

To correct these misconceptions,

communicators should first portray the cause of climate change as *using* too much fossil fuel (rather than "burning" too much such fuel or "emitting" too large a quantity of greenhouse gases). Second, they should make it clear that the problem is climate change—with its many ramifications—rather than global warming per se. And finally, because current cultural models will lead to ineffective solutions, communicators need to state the preferred solutions explicitly. Here they should make a point of saying that measures to improve energy efficiency (such as switching to fluorescent lights or driving cars that get good gas mileage) help prevent climate change and often pay for themselves in a short time. Communicators might also try to create a vision of a "renewable energy society," that is, one that relies heavily on renewable sources of energy. In the United States, for instance, they could point out that wind is nearly competitive with conventional energy sources in price and that the country has vast wind resources.¹⁹

Final Thoughts

Human beings do not just passively receive new information. On the contrary, they actively fit that information into preexisting cultural models and concepts. In most cases, this is a tremendous aid to understanding—with cultural models, people can come to terms with complex situations fairly quickly, correctly making the inferences and predictions those situations call for. This process works well in the case of relatively simple environmental issues (such as air and water pollution) where the prevailing cultural models largely match expert opinion. But as this article has shown, when it comes to new and complex problems such as global climate change, people often apply inappropriate models and thus draw invalid conclusions.

This article has outlined possible ways to improve public debate on global climate change. The sugges-

tions made here are not intended to be a comprehensive guide but rather to illustrate how to target a particular message more effectively. One question the article has not addressed is which entities should conduct environmental communication programs. Although schools, museums, and science news media have been active in this area (and can clearly use some of the concepts developed in this article to improve their message), the real question is what government should do. In the United States, only high elected officials have so far taken on the task of educating the public about environmental issues. The reason for this is that no one questions their right to campaign for their own policies, including any treaty commitments that may emerge from the Kyoto conference. But one might hope that someday the United States will follow Britain's lead and permit executive agencies and departments to design and implement serious information campaigns on important science policy issues, even though some consider these issues politically contentious.

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NOTES

1. Bureau of National Affairs, "Environment Poll Demonstrates Public Concern about Climate Change, Support for Treaty," press release (Washington, D.C., December 1996).
2. See Research/Strategy/Management, "Global Warming and Energy Priorities: A National Perspective," 1989 (unpublished survey results available from the Union of Concerned Scientists, Cambridge, Mass.); and G. Church, "A Call to Arms," *Time*, 22 February 1993, 27.
3. W. Kempton, J. S. Boster, and J. A. Hartley, *Environmental Values in American Culture* (Cambridge, Mass.: MIT Press, 1995), 124.
4. Ibid. This effort was the first to try to elicit the basic concepts and cultural models underlying environmental opinions in the United States, particularly those relating to global climate change. The author and his colleagues first conducted 43 semistructured interviews (in which they asked open-ended questions and followed up on any unexpected responses); then they surveyed 142 people using written questionnaires. Although the sample reflected a wide range of U.S. res-

idents (including people at both ends of the environmental spectrum), it was not truly random.

5. See D. C. Holland and N. Quinn, *Cultural Models in Language and Thought* (London: Cambridge University Press, 1987).
6. Untitled article, *U.S. News & World Report*, 28 May 1990, 23; S. Nassar, "Can Capitalism Save the Ozone?," *New York Times*, 7 February 1992, D2; and P. Lewis, "U.S. Informally Offers to Cut Rise in Climate-Warming Gases," *New York Times*, 29 April 1992, A10.
7. W. S. Broecker, "Man's Oxygen Reserves," *Science* 168 (26 June 1970): 1,537-38; and J. Harte and R. H. Socolow, *Patient Earth* (New York: Holt, Rinehart, and Winston, 1971), 281.
8. In the interviews, more of the respondents mentioned anthropogenic causes than natural ones. This may have been because the interview topic was initially described as "weather and the environment" or because of the particular way in which the questions were worded. Even so, the survey and other data clearly show that many people believe human activities strongly influence weather. See B. C. Farhar, "The Public Decides about Weather Modification," *Environment and Behavior* 9, no. 3 (1977): 279.
9. S. H. Schneider, lecture given at Princeton University, Princeton, N.J., March 1990.
10. For example, a person with biocentric values will probably be more concerned about species extinctions and less concerned about environmental health threats than a person with "human use" values will be. See Kempton et al., note 3 above, pages 85-115.
11. R. Gelbspan, *The Heat Is On: The High Stakes Battle over Earth's Threatened Climate* (Reading, Mass.: Addison-Wesley, 1997).
12. Kempton et al., note 3 above, pages 165-75.
13. Names withheld by request, personal communications with the author, 19-20 June 1996.
14. *Washington Post*, 24 June 1997, A3.
15. J. Warrick, "Clinton Outlines Global Warming Education Plan," *Washington Post*, 25 July 1997, A3.
16. For example, educational and psychological research has shown that if prior cultural models are not recognized and addressed in teaching physics (by giving exercises that show why they are wrong), students can take an entire course and not learn the new models being taught. See M. McCloskey, A. Caramazza, and B. Green, "Curvilinear Motion in the Absence of External Forces: Naïve Beliefs about the Motion of Objects," *Science* 210 (1980): 1,139; and D. Gentner and A. L. Stevens, *Mental Models* (Hillsdale, N.J.: Lawrence Erlbaum Associates, 1983).
17. R. Löfstedt, "An Evaluation of a U.K. Energy Conservation Programme," *Energy and Environment* 7, no. 1 (1996): 41.
18. M. G. Morgan, B. Fischhoff, A. Bostrom, L. Lave, and C. J. Atman, "Communicating Risk to the Public: First, Learn What People Know and Believe," *Science and Technology* 26, no. 11 (1992): 2,048-56. See also M. G. Morgan et al., "An Integrated Assessment of Climate Change" (presentation at the annual meeting of the Society for Risk Analysis, San Diego, Calif., December 1992).
19. These suggestions are intended to be illustrative rather than to provide a comprehensive survey of the available approaches. A more thorough communication strategy, for example, would attempt to dispel the confusion between greenhouse warming and ozone depletion rather than focusing primarily on the desired policy outcomes. Similarly, it would try to refute the pollution model point by point (e.g., by attacking the notions that greenhouse gases are toxic and that filters are the solution) instead of merely avoiding language that connotes the pollution model. Before being used, any communication strategy should be tested against the intended audience's perceptions and then revised if necessary.

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